

BOOK REVIEW

FUNDAMENTALS OF EARTHQUAKE PREDICTION, Cinna Lomnitz,
Wiley, New York (1994). Number of pages: 326.

The title of this book 'Fundamentals of Earthquake Prediction', conveys the impression that this is a textbook on predicting the magnitude, location and time of occurrence of future earthquakes, or the probability of occurrence within a given time frame. This is no textbook. It is a very personal view of a controversial field. As the author puts it: 'Today it would take a Galileo to find his way in the earth sciences'. The author, like a latter day Renaissance man, surveys the scene with a critical eye and comments authoritatively on every aspect of it.

The author is at his interesting and provocative best in discussing the successes and failures of earthquake prediction such as the Haicheng earthquake in China (success?) and the Parkfield earthquake (pending – failure?). The themes range from political pressure to the use and abuse of statistics, and the alleged shirking of professional responsibilities. Here the insider anecdotes, the low-down on how things were actually done and the clarifying capability of hindsight makes for exciting reading. However, the author himself may have become a victim of hindsight. In discussing the official Japanese earthquake prediction program, which began in 1964, he makes the following statement, '*Japan is today, the best protected nation against disasters in spite of the high incidence of major earthquakes*'. After Kobe, would he make the same confident assertion today?

The author devotes a great deal of attention to the role of precursors in predicting earthquakes. The issue here is whether 'special' events or perturbations in normal behaviour presage earthquakes. He discusses foreshocks, increases in radon concentration in wells, fluctuations in water levels, variations in electrical potential and the behaviour of animals. He points out that many of these precursors were identified after the event but would have been very difficult to detect before the event because of the low signal-to-noise ratio. In the case of animals, their behaviour before thunderstorms or earthquakes seems to be indistinguish-

able. The author makes it clear that while precursors are worth studying, one has to be skeptical in dealing with some of the accounts in the literature. What is needed is the attitude of Hotspur from Henry IV, Part I, Act III,

GLENDOWER: At my birth
The frame and huge foundation of the earth
Shak'd like a coward.

HOTSPUR: Why, so it would have done
At the same season, if your mother's cat
Had but kitten'd.

This and many other apposite allusions enliven the text.

The author shows a predilection for the role of fractality, dynamic chaos and self-organized criticality in seismology, with references from Heracitus, 553–475 BC, to Mandelbrot in our time. He discusses self-organization with a beautiful example from a description of thawing in Thoreau's '*Walden Pond*'. The speculations here are intriguing but this section is a diversion from the main line of the book and to this reviewer some of the philosophical arguments seemed a trifle strained.

The author returns to form when he gives his critical attention to geotechnical and structural engineering. The author's insights are fresh and illuminating and his love affair with gravity waves is clearly evident. He considers gravity waves to be the prime factor in causing damage to structures on soft soils. By analogy with gravity waves in the ocean, he appears to be equating the presence of gravity waves with liquefaction whether or not the phase transformation is generated by increasing porewater pressure.

As the Rayleigh wave switches to a gravity wave at the phase transformation, the motion changes from retrograde to prograde with, in the author's view, serious consequences for structural safety. He presents a very original scenario for the failure of the Cypress Street Overpass in Oakland during the

Loma Prieta earthquake in 1989. He attributes the failure to spatial resonance caused by waves with a wavelength corresponding to inter-bent spacing which were generated by phase transformation in the Bay mud. The prograde motion of these waves caused the bents to tilt longitudinally and caused the upper deck to buckle when the greater resistances of the bents located in Merritt sands were encountered. This buckling then tore the bents apart in the vertical direction. The official explanation of failure was that the bents failed in transverse loading.

The author accuses seismologists and engineers of ignoring non-linearity and still doing their calculations as if the ground were elastic. That view may be substantially true as far as seismologists are concerned, but geotechnical engineers who practice the state-of-the-art, have been doing non-linear site response calculations for about twenty years, and today nearly every analysis of major earth structures under seismic excitation is done using some form of non-linear analysis.

Some of the data on which the author makes arguments about site response in Mexico City appear to be out of date. His conclusions regarding the properties of Mexico City clay comes from a 1982 reference. Detailed studies of Mexico City

clay since the 1985 earthquake have shown that the loss in stiffness at strains of 10^{-1} per cent are about 10 per cent not 20 per cent, and the fall-off at higher strains is slower than that shown by the author in his text. In discussing liquefaction, the author cites some evidence of liquefaction on the moon and gets excited about the possibility of liquefaction in dry materials. Liquefaction in dry materials has been noted in the past in loessial soils in the Xait region in the USSR. In these cases, the liquefaction resulted from the loss of frictional resistance due to the high pressures in the entrained air on collapse of the loessial structure during shaking.

This book is a joy to read and should be read by anyone involved in earthquake hazard mitigation. It gives not only the nuts and bolts of the subject but also the taste and the flavour. The diverse topics mesh together harmoniously into an interesting and exciting work.

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